

Near-surface vertical structure in temperature and salinity in the SPURS study area

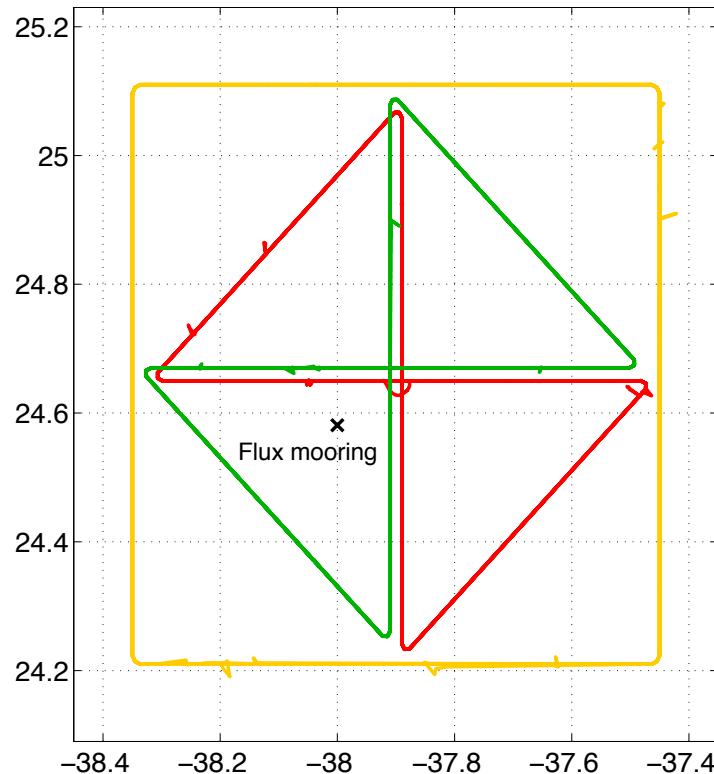
Ben Hodges

Dave Fratantoni





SPURS Wave Glider operations

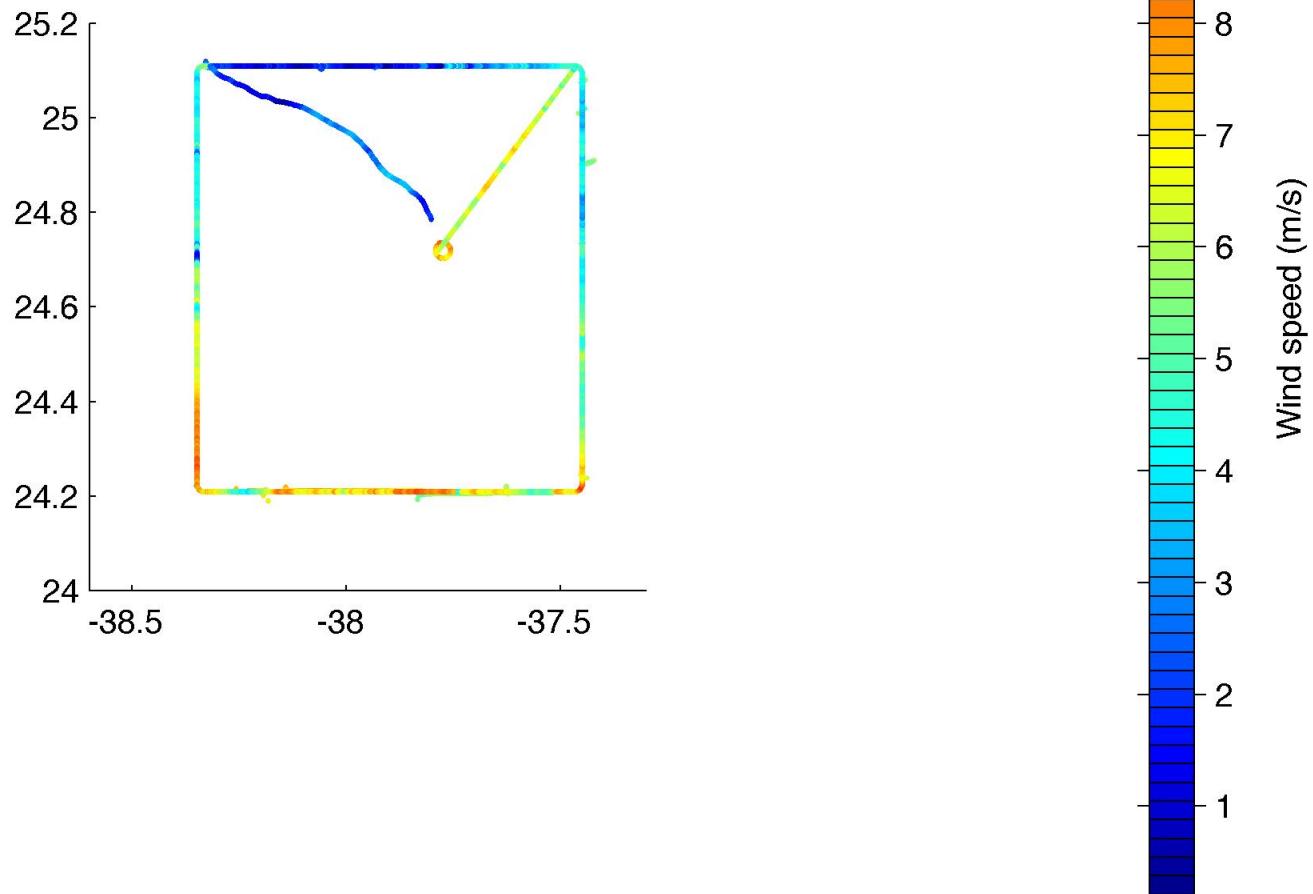


- 3 vehicles
 - “Red”
 - “Yellow”
 - “Green”
- 100-km square
- 1 year
- Sea-Bird GPCTDs
 - 30 cm
 - 6.5 m

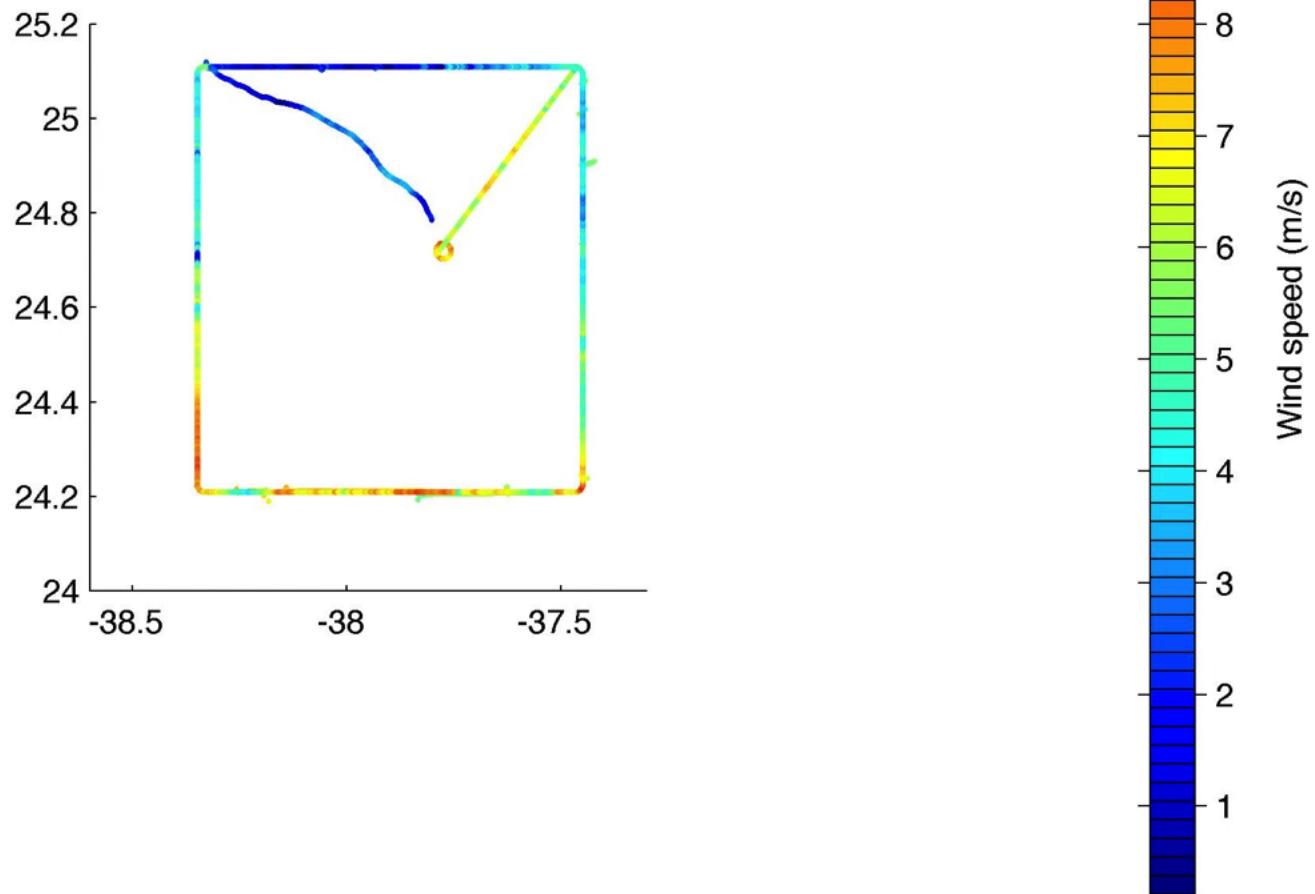
	Red	Yellow	Green
Laps, Sep '12 – Mar '13	14	15	35
Laps Apr '13 – Sep '13	20	22	25

= 43,000 km

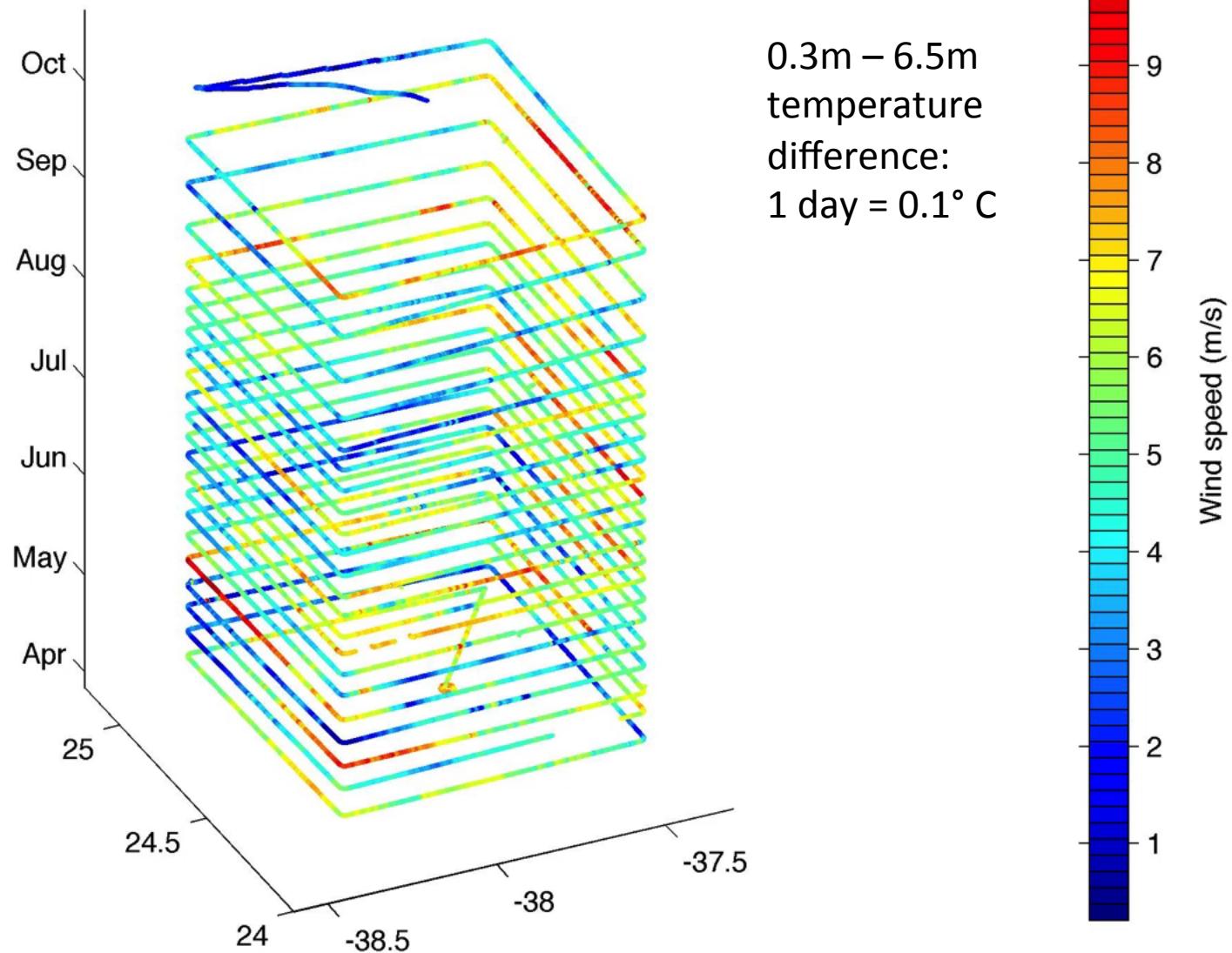
Apr-Sep 2013 track of Wave Glider “Yellow”



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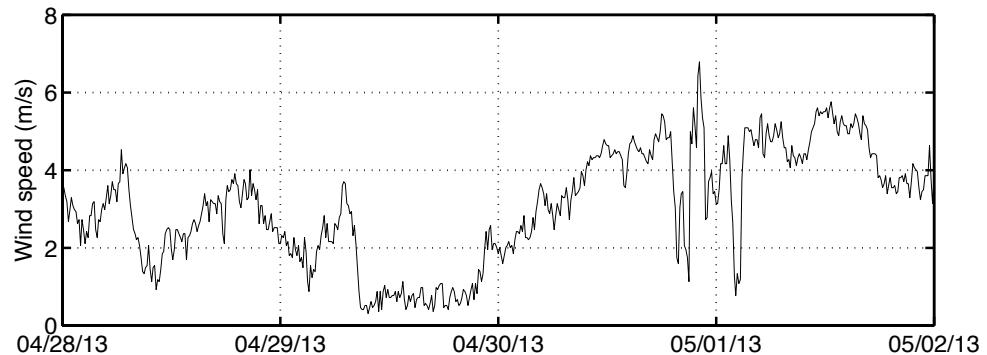
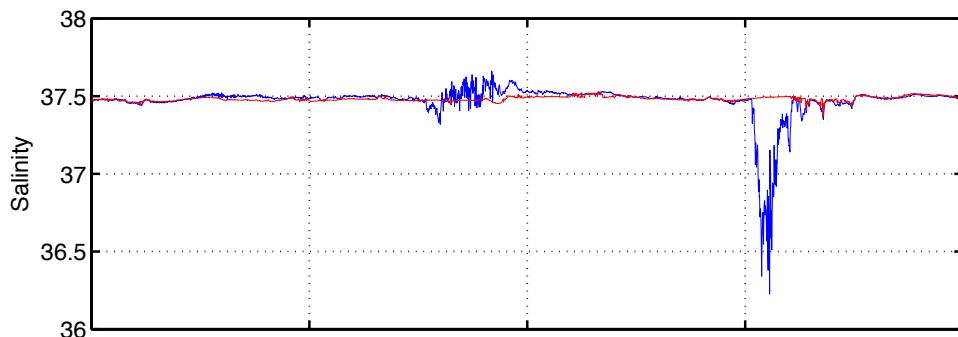
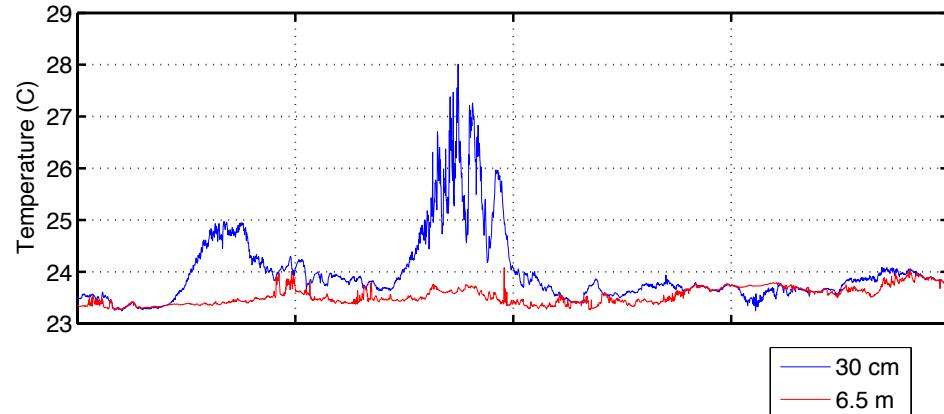
Highest anomalies in T and S at 30 cm relative to 6.5 m

WG "Yellow", 29 April 2013

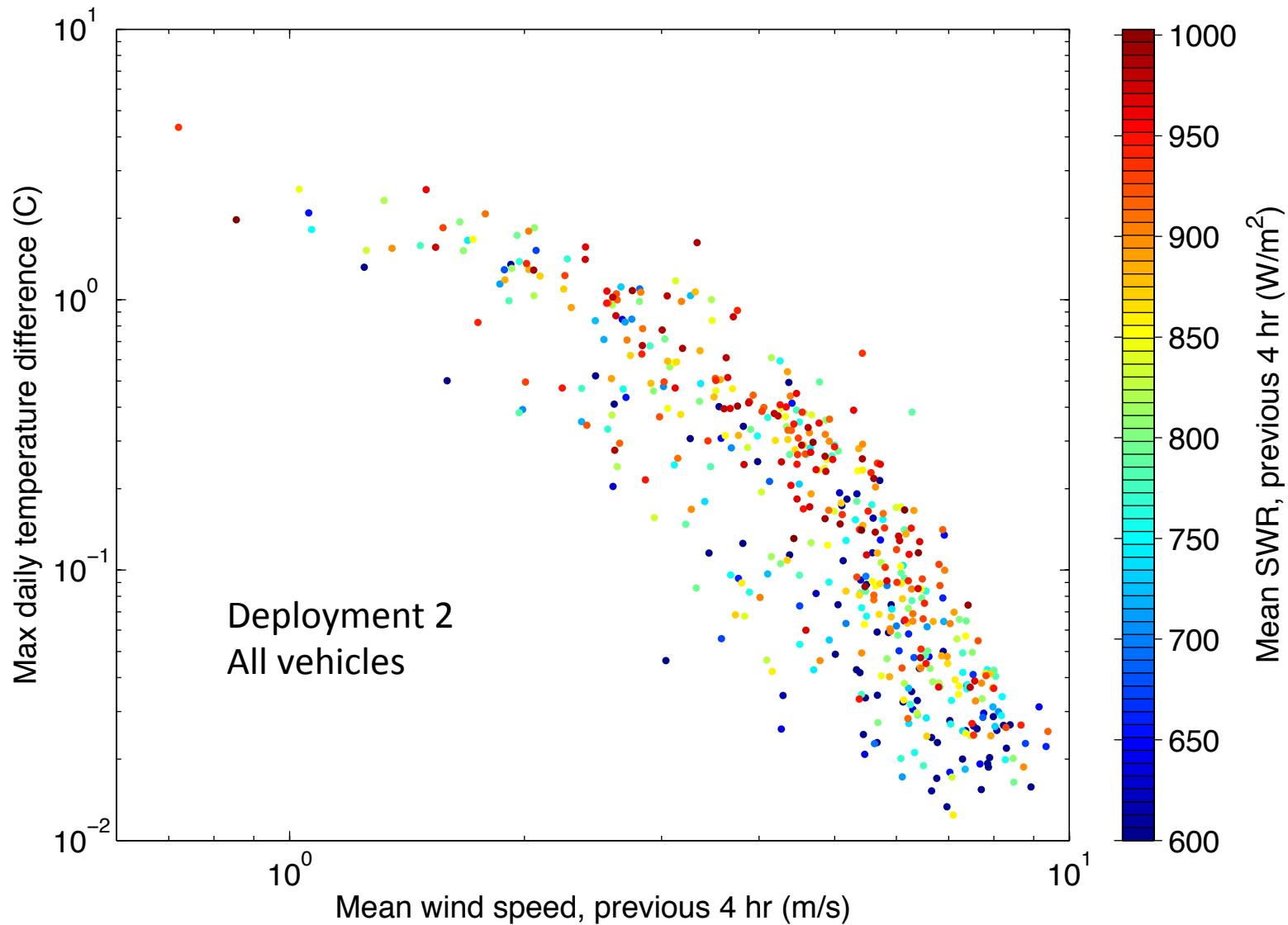
- Temperature: $> 4^\circ \text{C}$
- Salinity: $\sim 0.2 \text{ psu}$

Wind speed $< 1 \text{ m/s}$ for 12 hours
(unique event)

4-hour mean SWR: 930 W/m²
(80th percentile)



Diurnal warming observations: $T(30\text{ cm}) - T(6.5\text{ m})$

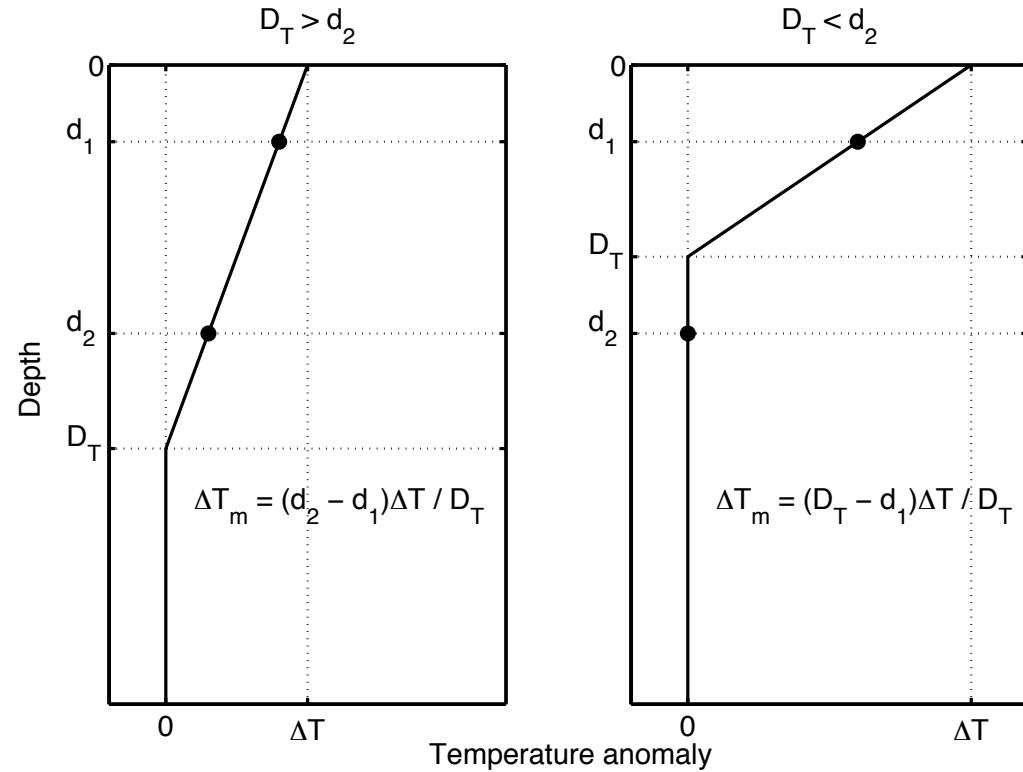


Simple diurnal warm layer (DWL) model of Fairall et al. (1996)

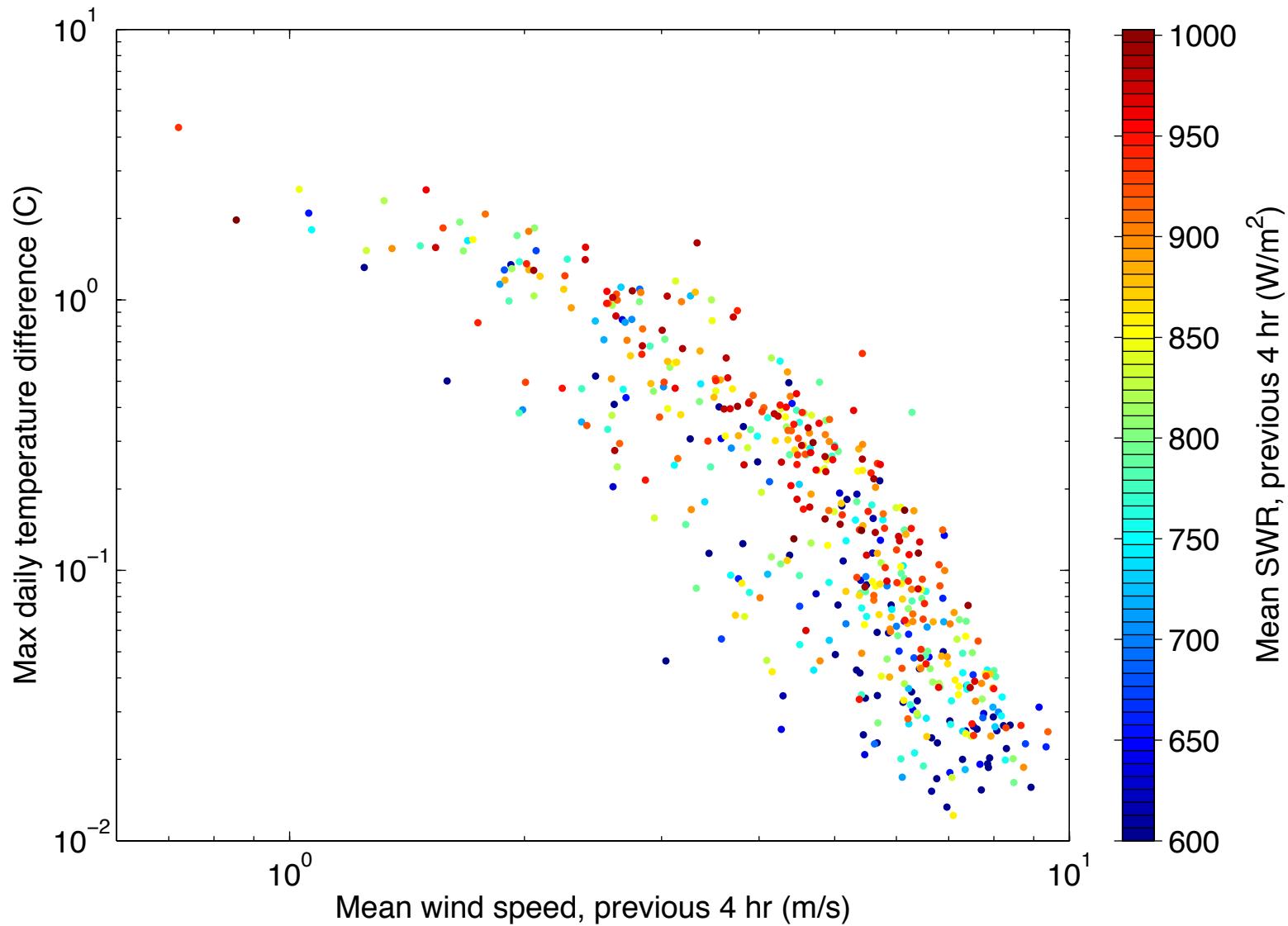
- Temperature and velocity vary linearly within the DWL
- Depth of DWL (D_T) determined from integrated inputs of heat (I_S) and momentum (I_τ) by maintaining a critical bulk Richardson number of 0.65
- Expression for ΔT_m , the expected temperature difference between sensors at depths d_1 and d_2 , changes when the bottom sensor crosses the DWL base

$$D_T = (2R_{ic})^{1/2} \frac{I_\tau}{(\alpha g I_S / \rho c_p)^{1/2}}$$

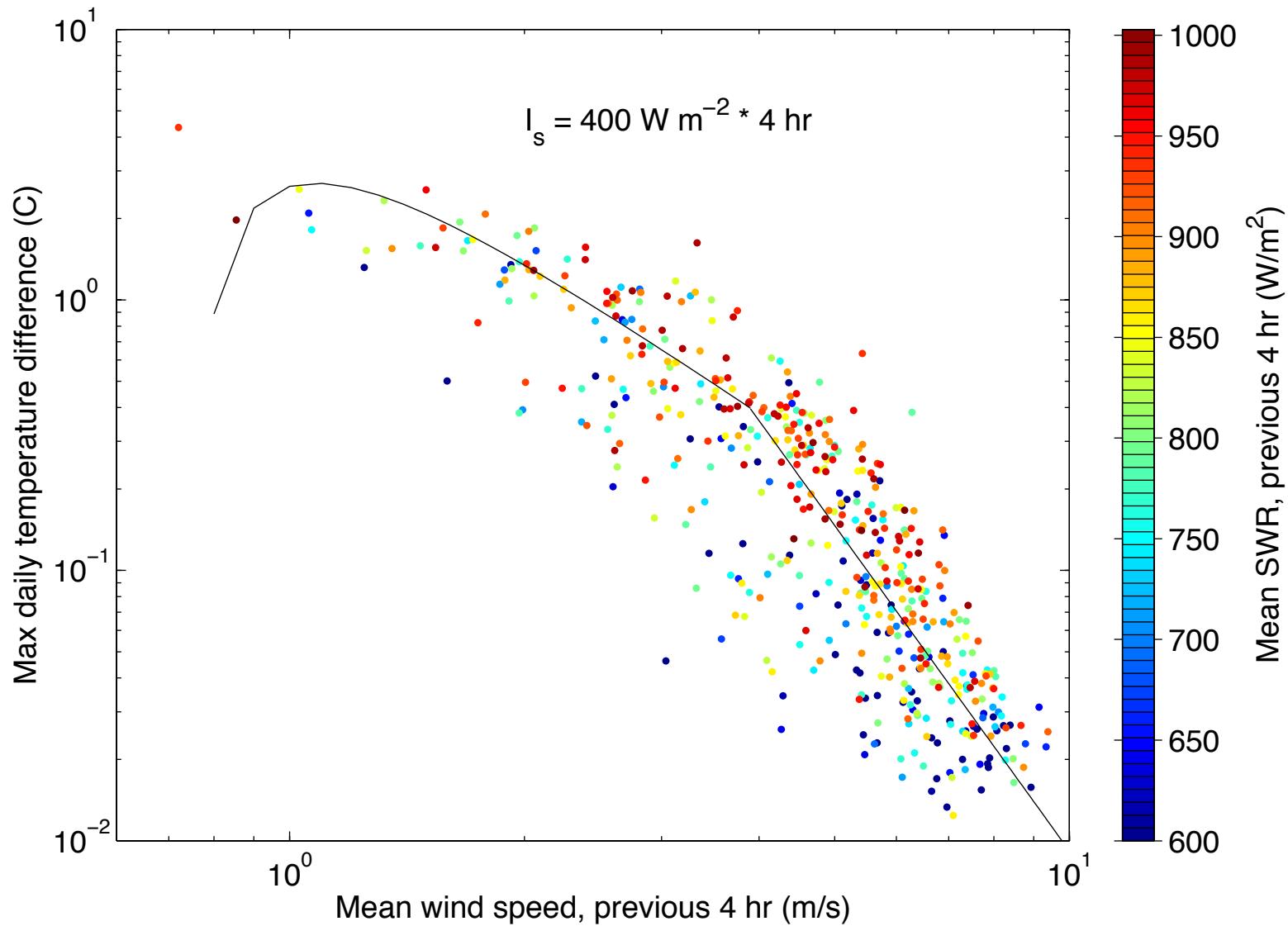
$$\Delta T = \frac{2I_s}{\rho c_p D_T}$$



Diurnal warming observations: $T(30\text{ cm}) - T(6.5\text{ m})$



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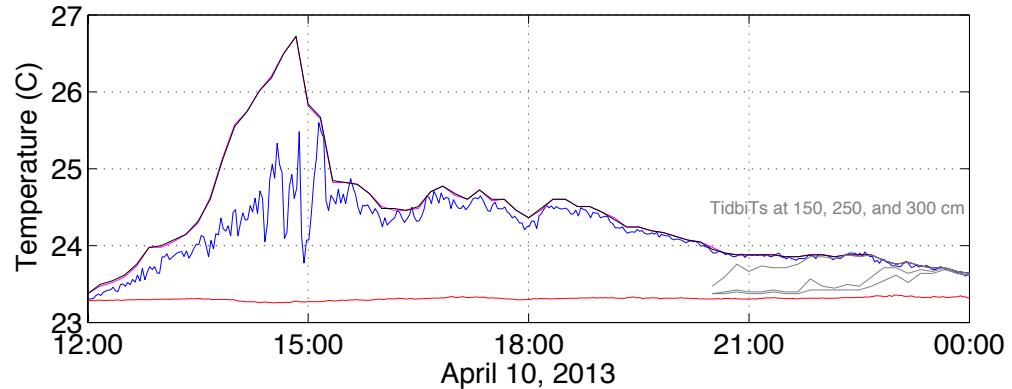
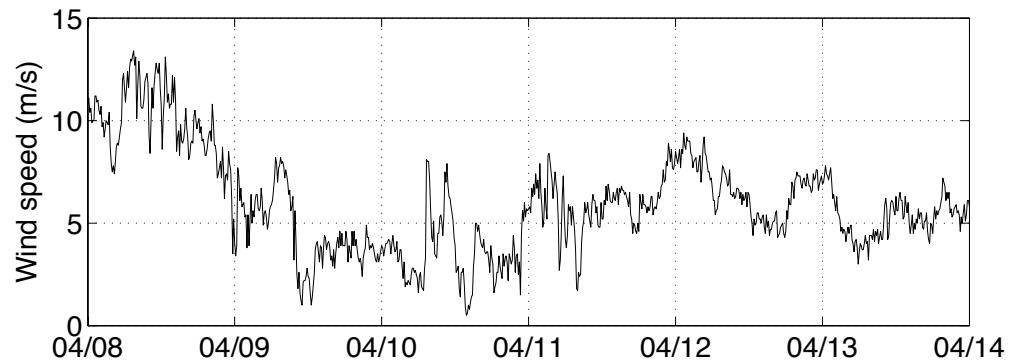
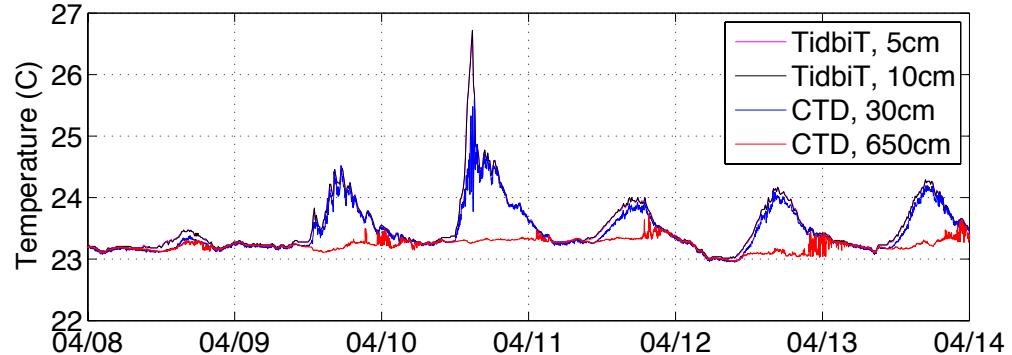
Warming above 30 cm

178 days of 10-min TidbiT temperature samples at 5 cm and 10 cm.

One day had surface warming $> O(0.1^\circ \text{ C})$ relative to 30 cm.

April 10, 2013:

- wind dropped below to $\sim 0.5 \text{ m/s}$ for 1 hour.
- 10-min average temperature difference reached 1.9° C at local noon.

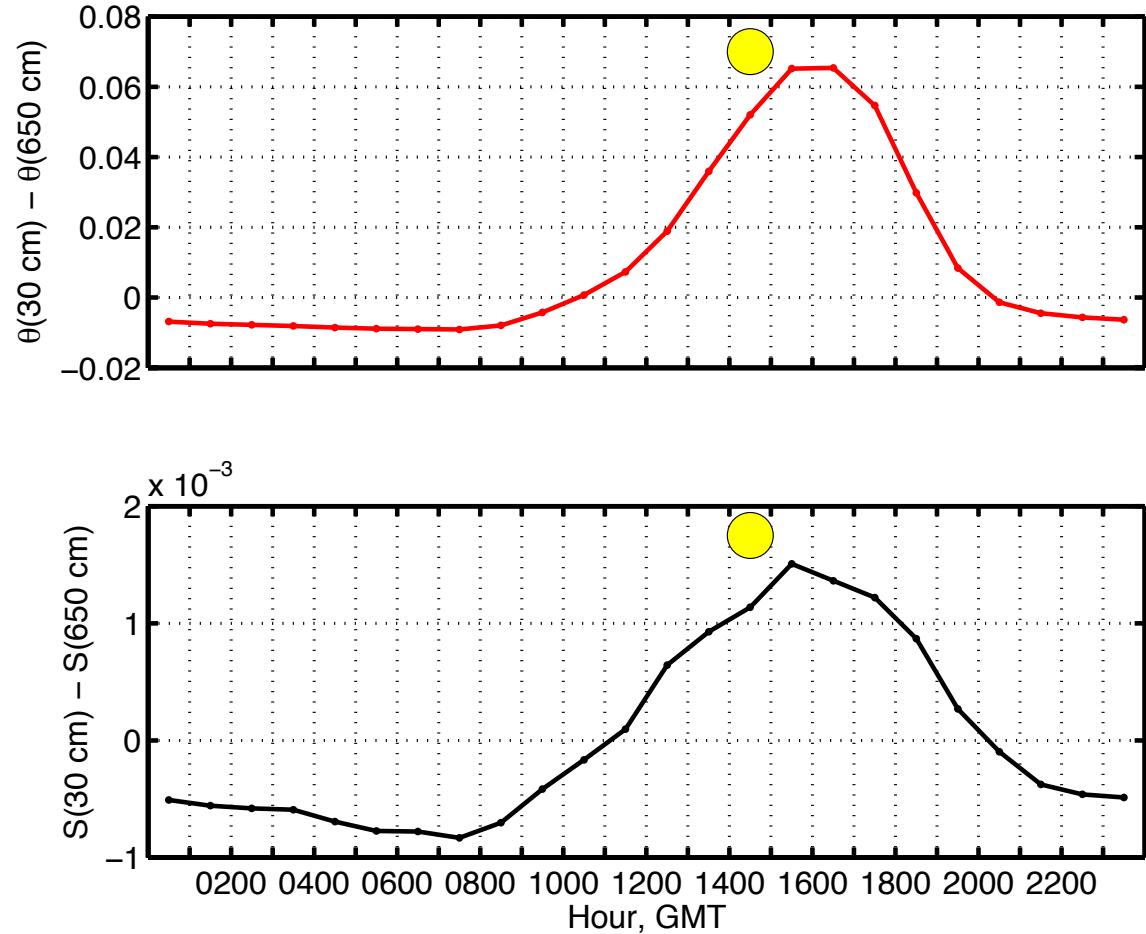


“Median day”: hourly averages of ΔT and ΔS between 30 cm and 6.5 m

Surface temperature peaks at ~13:30 L at +0.065° C relative to 6.5 m.

Surface salinity peaks at roughly the same time. Amplitude of the diurnal cycle at the surface relative to 6.5m is ~0.002 psu.

During nighttime convection, surface temperature is -0.008° C relative to 6.5 m.

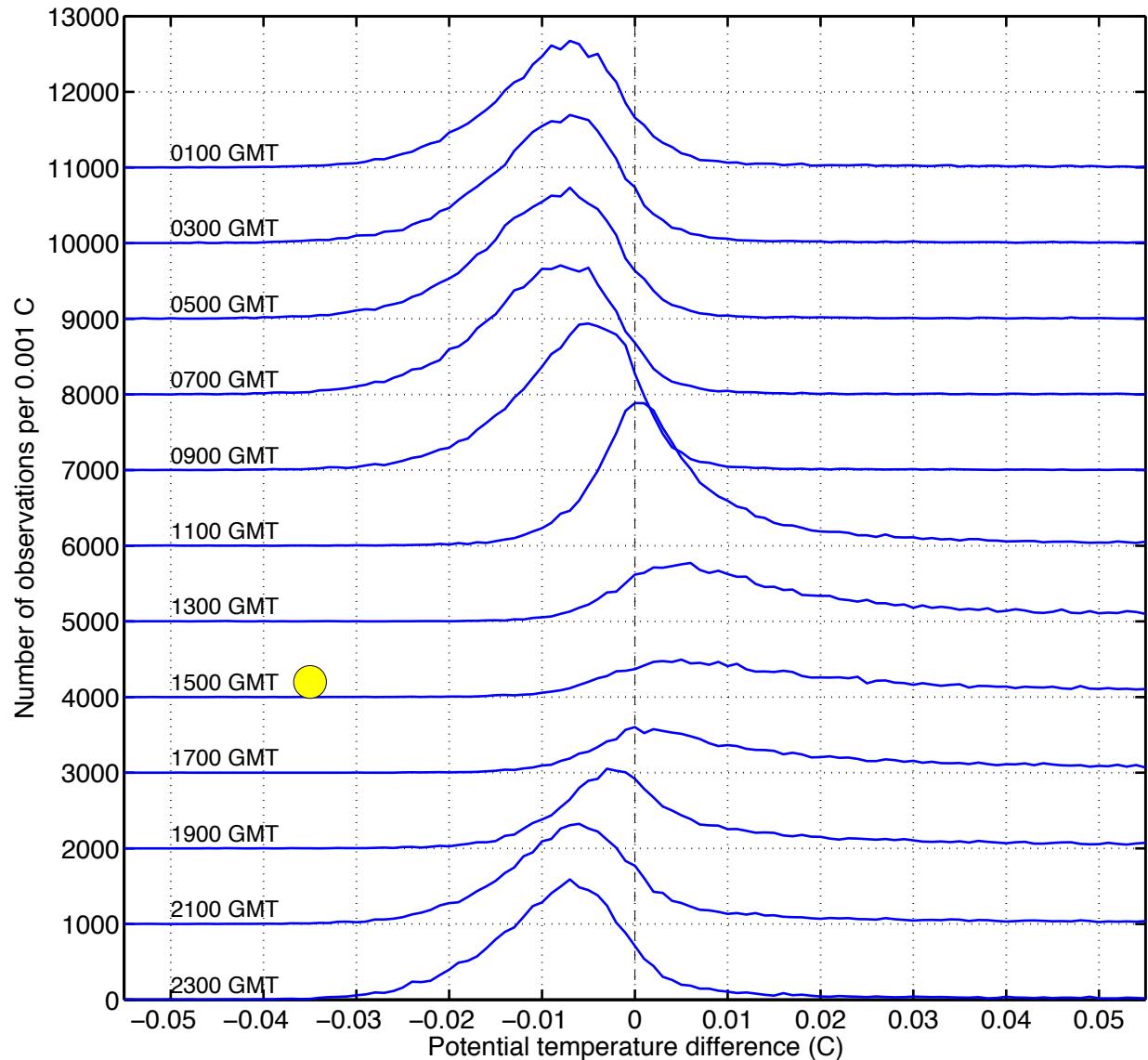


Distribution of $[\theta(30 \text{ cm}) - \theta(6.5 \text{ m})]$ by time of day

Vertical temperature gradient:

- superadiabatic at night (Anis & Moum 1992)
- highly peaked around zero shortly after sunrise when surface heat flux switches sign and convection shuts down
- broadly distributed through the day with mode positive but very small

Statistical test of parameterizations of physics in the OSL?



Conclusions

- Extreme cases of stratification in the diurnal warm layer documented: 4.3° C and ~ 0.2 psu in the upper 6.5 m; 1.5° C in the upper 30 cm.
- Wave Glider measurements of diurnal warming of the ocean surface layer in the SPURS region are generally well fit by the model of Fairall et al. (1996).
- Large number of accurate samples of ΔT and ΔS together with surface fluxes and other measurements (swell?) could facilitate robust statistical tests of parameterizations of OSL physics, particularly very near the surface.